Tenodermodesis for the Treatment of Late-Presenting Tendinous Mallet Finger Deformities in Children and Adolescents

Andrés Ferreyra, Pablo L. Eamara, Lucas M. Lanfranchi, Victoria M. Allende Nores, Julio J. Masquijo
Pediatric Orthopedics and Traumatology Department, Sanatorio Allende, Córdoba, Argentina

ABSTRACT

Introduction: Tendinous mallet finger may go initially unnoticed in children and adolescents, limiting the possibilities of conservative treatment. The aim of this study was to evaluate the outcomes of surgical treatment with the tenodermodesis technique in late-presentig injuries. **Materials and Methods:** Nine patients (8 males) with an average age of 8.6±6 years (1-15 range) were retrospectively evaluated. The injury manifested at an average of 27±11.4 days after trauma (15-45 range). In 4 patients the mechanism was a laceration and, in 5, indirect trauma. Patients were treated by tenodermodesis and transitory fixation of the distal interphalangeal joint with a Kirschner wire. The average follow-up was 61±34.7 months (12-106 range). Active and passive range of motion of the distal interphalangeal joint (DIPJ), pain, deformity, limitations in everyday life activities, and need for further treatment were evaluated. Crawford criteria was used to evaluate the outcomes. **Results:** The results were excellent in eight patients, and fair in one according to the Crawford criteria. One case required reintervention for re-rupture in a poorly collaborating patient. Two cases presented granuloma as a complication and required resection. No patients presented pain at the last follow-up, nor limitations in everyday life activities. Eight patients had full active DIPJ extension, and one had a 20° residual deformity. **Conclusion:** Tenodermodesis allows anatomical reconstruction of the extensor mechanism in pediatric patients. The clinical results are encouraging in late-presenting lesions.

Key words: Mallet finger; tenodermodesis; late presentation; pediatric.
Level of Evidence: IV

Tenodermodesis para el tratamiento del dedo en martillo tendinoso de presentación tardía en niños y adolescentes

RESUMEN

Introducción: El diagnóstico del dedo en martillo tendinoso puede pasar desapercibido inicialmente en niños y adolescentes, esto limita las posibilidades del tratamiento conservador. El objetivo fue evaluar los resultados del tratamiento quirúrgico con la técnica de tenodermodesis en lesiones de presentación tardía. **Materiales y Métodos:** Se evaluó retrospectivamente a 9 pacientes (8 niños) con una edad promedio de 8.6 ± 6 años (rango 1-15). Los días promedio de evolución de la lesión eran 27±11.4 (rango 15-45). El mecanismo de lesión fue una herida cortante (4 casos) y un traumatismo indirecto (5 casos). El tratamiento consistió en tenodermodesis e inmovilización transitoria con clavija transarticular. El seguimiento promedio fue de 61 ± 34.7 meses (rango 12-106). Se evaluaron la movilidad activa y pasiva de la articulación interfalángica distal, la presencia de dolor o deformidad, la limitación de actividades de la vida diaria y la necesidad de tratamientos adicionales. Se clasificaron los resultados con los criterios de evaluación de Crawford. **Resultados:** En 8 pacientes, el resultado fue excelente y, en uno, regular según Crawford. Un paciente poco colaborador requirió una segunda intervención por re-rotura. En dos casos, hubo una complicación (granuloma) y requirió resección. Ningún paciente refirió dolor al final del seguimiento, ni limitaciones para las actividades de la vida diaria. Ocho presentaron extensión activa completa y uno, una deformidad residual de 20°. **Conclusión:** La tenodermodesis permite la reconstrucción anatómica del mecanismo extensor en niños y adolescentes. Los resultados clínicos de este estudio son alentadores en lesiones no diagnosticadas en forma temprana.

Palabras clave: Dedo en martillo; tenodermodesis; presentación tardía; pediátrico.
Nivel de Evidencia: IV

Received on July 21st, 2019. Accepted after evaluation on June 27th, 2020 • ANDRÉS FERREYRA, MD • and_ferreyra@yahoo.com.ar https://orcid.org/0000-0003-1163-7114

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INTRODUCTION

Breaches of the extensor mechanism near the distal interphalangeal joint (DIP) can produce mallet finger injuries[1-6]. These injuries can be bony or tendinous. They typically produce extension deficit and functional impairment of the DIP joint[4]. The injury is usually instigated by trauma on the fingertip or even by open wound[7,8]. Early diagnosis can be challenging in children and adolescents, due to the initial presence of edema and the difficulty of examining a young child [7]. Moreover, the extension lag may not be evident upon first examination[7]. In the cases where it is properly diagnosed and treated, the splint may not be properly applied by the patients, leaving them with a chronic injury[7,9]. Most authors classify injuries as acute when they are treated within a 2-week period[10-12] and as chronic when they are treated after 4 weeks[1,10,13]. Altan et al. consider late-presenting injuries are those which are treated 2 weeks after sustaining the trauma[11].

Numerous techniques for the treatment of chronic tendinous mallet finger have been described: central slip tenotomy, spiral oblique retinacular ligament reconstruction, wire insertion, arthrodesis, chondrodesis, among others[1,4-6,13-15]. Tenodermodesis was reported by Iselin et al.[9] in 1977. It has the advantage of approximating the extensor tendon with the full thickness of skin and subcutaneous cell tissue, improving mechanical integrity and vascularization in the area and thus increasing healing potential.[4] Moreover, from the technical point of view it is simpler than the other aforementioned options.[4,6,7,9]

Tenodermodesis outcomes in the adult population have been widely reported.[1,2,6,9,13,16-19] However, there is scant information available regarding pediatric patients.[4,7] The aim of this study was to assess tenodermodesis outcomes in a series of pediatric and adolescent patients with late-presenting tendinous mallet finger injuries.

MATERIALS AND METHODS

Level of evidence: IV - Case series (therapeutic study).

Following approval by the ethics committee of the institution, a retrospective review was made on the health records of all pediatric patients with a tendinous mallet finger diagnosis who had undergone tenodermodesis surgery more than 15 days after sustaining the injury, between January 2008 and April 2016. All patients were treated in the same institution by two pediatric orthopedic surgeons. The analysis included 9 patients (8 males and 1 female), with an average age of 8.6 ± 6 years (from 1 to 15 years). The injury had an average progression of 27 ± 11.4 days (from 15 to 45 days). The injury was caused by laceration in 4 patients and by indirect trauma of the finger in 5 patients. Minimum follow-up was of 12 months, ranging from 12 to 106 months (Table 1).

Table 1. Demographic data of the patients

n	Age	Sex	Hand	Finger	Mechanism	Evolution time (days)	Previous treatment	Follow-up (months)
1	15	M	R	5th	Indirect trauma (rugby)	30	No	106
2	4	M	R	3rd	Cut (glass)	15	Skin suture	91
3	2	M	L	3rd	Cut (bicycle)	21	Skin suture	89
4	15	F	L	4th	Indirect trauma (volleyball)	20	No	80
5	9	M	R	4th	Indirect trauma (ball pit)	30	No	75
6	4	M	R	3rd	Crushing (door)	45	Reduction and osteosynthesis with wire on the 2nd phalanx	55
7	13	M	L	4th	Cut (axe)	30	Skin suture	34
8	15	M	R	5th	Indirect trauma	15	No	14
9	1	M	R	2nd	Cut	45	Skin suture	12

F = female, M = male.

Surgical technique and postoperative care:

All patients underwent the same surgical technique. The procedure was performed in an operating room under sedation with ambulatory care. A prophylactic dose of cefazolin, based on the patient's weight, was intravenously administered 30 minutes before incision. The patient was placed in supine decubitus position with the limb on a hand table and a tourniquet cuff was placed. The DIP joint was temporarily fixated with a K-wire (Figure 1). A dorsal approach was performed on the DIP crease, which can be amplified in an S or H shape (Figure 2), according to the surgeon's preference. The edges of the extensor tendon were identified and carefully dissected, verifying that they could be approximated without tension. The tendon, subcutaneous cell tissue and skin were sutured in one plane with non-absorbable, monofilament material (Figure 3). A sterile dressing and metal finger splint were applied. The K-wire was removed after 4-7 weeks, depending on the surgeon's criterion.

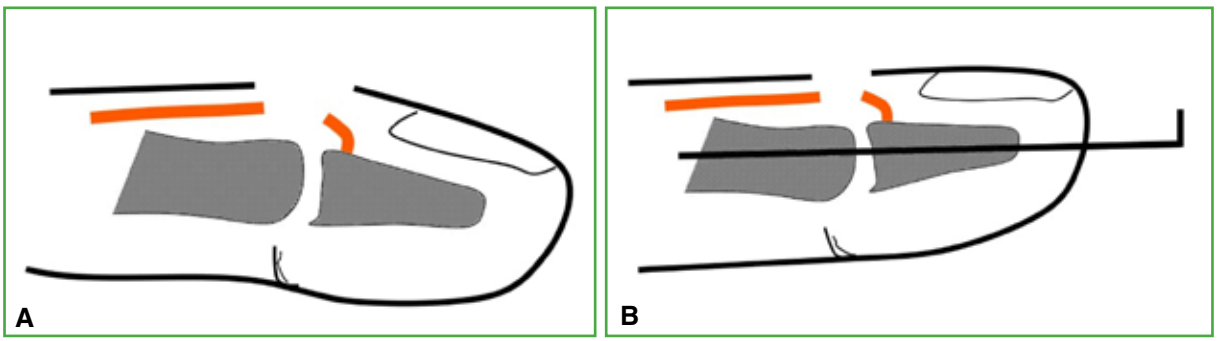

Figure 1. **A.** Initial extension defect. **B.** Transient retrograde interphalangeal wire fixation.

Figure 2. H-shaped approach for the surgical treatment of mallet finger with tenodermodesis. The transversal incision must be performed on the flexion crease of the DIP joint.

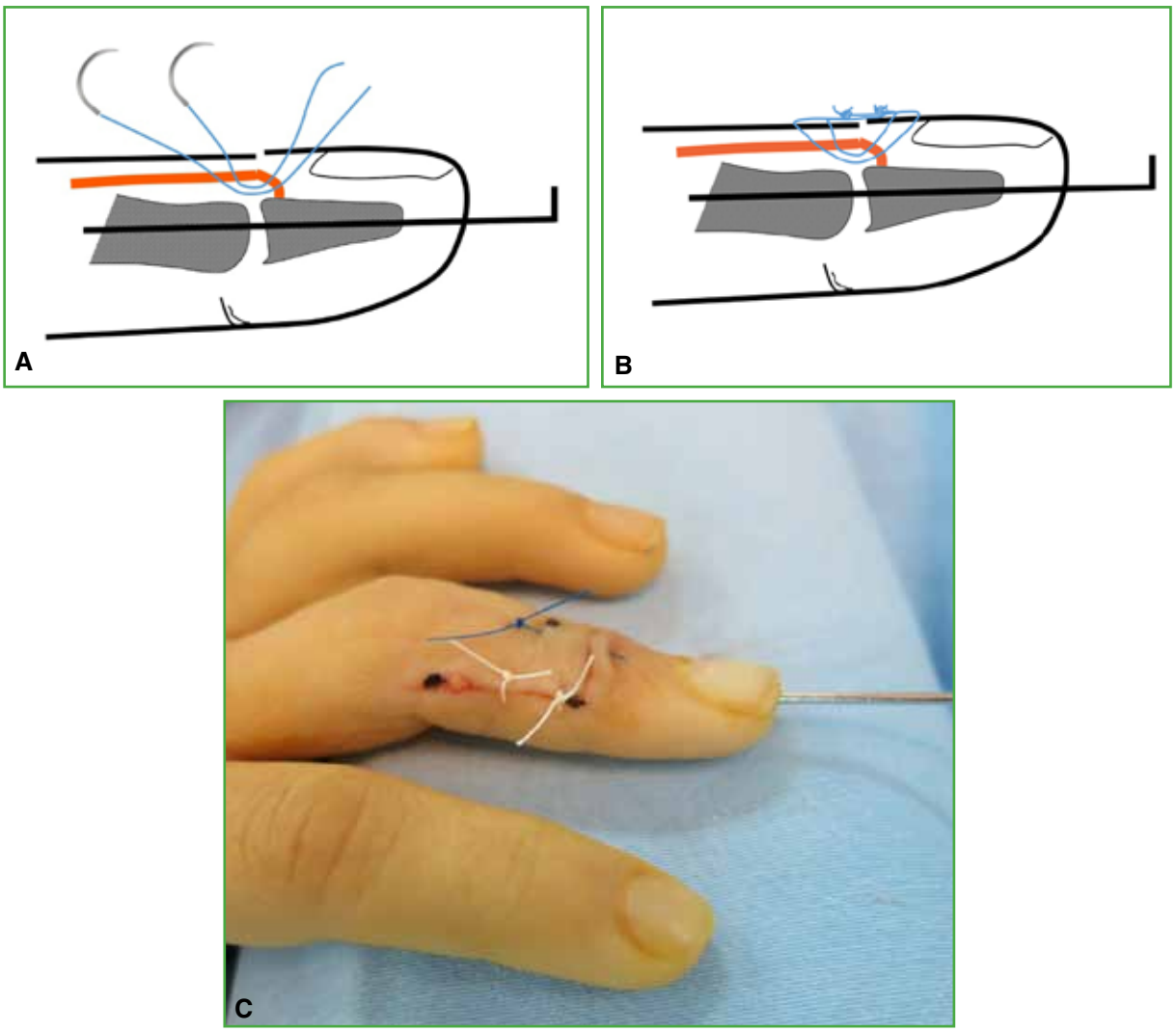

Figure 3. A and B. Suture with non-absorbable monofilament material, including the tendon, subcutaneous tissue and skin. **C.** Clinical image of the sutured wound of a patient with S-shaped approach.

Patient evaluation:

In the last period of follow-up, the patients were evaluated on the active and passive range of motion of the DIP joint, the presence of pain or deformity, everyday life limitations and need for additional treatment. The results were classified according to Crawford's criteria[20], wherein an outcome is considered excellent when there is full extension and full and painless flexion of the DIP; good when there is an extension deficit of 0 to 10º and full and painless flexion; fair when there is an extension deficit of up to 25º and any degree of painless loss of flexion; and poor when the extension deficit is greater than 25º or there is persistent pain (Table 2).

Table 2. Crawford criteria[20]

Classification	Description
Excellent	No pain; full flexion and extension of the DIP joint
Good	No pain; 0°-10° extension deficit, full flexion of the DIP joint
Fair	No pain; 0°-25° extension deficit, loss of some degree of flexion
Poor	Persistent pain; >25° extension deficit

Statistical Analysis:

Descriptive statistics were used for the description of quantitative variables (average, standard deviation and range) whereas absolute frequencies were used for qualitative variables.

RESULTS

According to Crawford's criteria[20], excellent results were obtained in 8 patients and a regular result was obtained in the remaining patient (Table 3). By the end of follow-up, all patients performed everyday activities without limitations or pain. DIP extension was complete in all patients (Figure 4) but one, who had a residual deformity of 20° (case 6).

Table 3. Treatment, results, complications and follow-up

n	Immobilization time (weeks)	Outcome*	Complication	Second surgery
1	7	Excellent	No	No
2	5	Excellent	Granuloma	Granuloma resection
3	5	Excellent	Granuloma	Granuloma resection
4	6	Excellent	No	No
5	6	Excellent	No	No
6	6	Fair	Re-rupture	Revision
7	5	Excellent	No	No
8	7	Excellent	No	No
9	4	Excellent	No	No

*According to Crawford Criteria[20]

Figure 4. Clinical appearance before and after treatment.

The most frequently affected fingers were middle and ring fingers (3 cases each), 2 cases were on the little finger and one case was on the index. In 5 patients treatment was delayed by an erroneous initial diagnosis. These were the 4 open wound cases, which had only received skin suture, and one case with a middle phalanx fracture in the same finger, which had been treated with reduction and osteosynthesis with percutaneous wiring. In the latter, the diagnosis was made when the wires were removed and the extension deficit of the DIP was discovered. The 4 remaining patients consulted late.

Three patients required reinterventions. A patient lost transient fixation and the correction was broken 2 weeks postoperatively. In this case, a revision tenodermodesis was performed and a good outcome was achieved. Other 2 patients presented wound granuloma which had to be excised.

DISCUSSION

Mallet finger is a frequent injury in the pediatric-adolescent population.[4] The disruption of the extension mechanism in the DIP joint can be caused by an avulsion fracture of the epiphysis or, less frequently, by a tendinous injury. When diagnosed early, conservative treatment tends to be effective in most cases.[1,3,10,11,19,21,22] However, in many cases the diagnosis may be delayed because the injury goes unnoticed or immobilization is not performed or maintained correctly. Late-presenting patients usually report pain, aesthetic discomfort and limitations in everyday activities.[18]

The optimal treatment for chronic or late-presenting mallet finger injuries remains controversial[1,3,6]. Some authors recommend conservative immobilization treatment during 6-8 weeks before considering surgery[4]. Good outcomes using this approach have been reported in adults.[2,10,11,22] There are no series evaluating conservative treatment in pediatric patients with chronic mallet finger. However, due to the healing potential of children, it is logical to think that the outcomes would be even better than in the adult population. We consider it convenient to try conservative treatment for at least 6 to 8 weeks before indicating surgery.

Numerous surgical techniques have been described. Fowler's tenotomy of the central slip provides balance to the extensor mechanism by resecting the insertion of the central slip, which increases excursion and strength of the distal insertion, but requires incision of a previously healthy portion of tendon. In a series of adult patients, 1 out of 4 cases had residual deformity after undergoing this technique[23]. Oblique retinacular ligament reconstruction requires using a free graft from the palmaris longus tendon[24,25]. Reattachment with wire attempts to convert a chronic injury into an acute one, by suturing the tendon to the distal phalanx[14], but it requires damaging the distal insertion site, risking epiphyseal plate injury. Arthrodesis has the disadvantage of limiting range of motion of a healthy joint[26]. Compared to other options, tenodermodesis is a technically simple procedure[4,6,7,9].

By repairing the tendinous injury together with skin and subcutaneous cell tissue, it allows a more resistant reconstruction from the mechanical point of view and provides additional vascularization for healing[4]. Numerous series of adult patients have been published. Iselin et al. reported 22 satisfactory results in 26 patients[9]. In Warren et al., 4 out of 6 patients improved, whereas 1 did not experience any changes and the one remaining worsened[16]. Kon and Bloem published 26 excellent results in 27 patients[17]. Sorene and Goodwin stated that tenodermodesis improved the extension deficit from 50° to 9° in a series of 16 patients, although they reported a certain limitation in flexion[6]. Only two articles[4,7] about tenodermodesis for the treatment of chronic tendinous *mallet finger* in the pediatric population have been published (Table 4). De Boek and Jaeken[7] reported 4 cases, all of them with excellent outcomes. Kardestuncer et al.[4] obtained 8 excellent outcomes and 2 good or regular outcomes in their 10-patient series. The outcomes of our series are comparable to those previously published by those authors.

Table 4. Comparison of publications on tenodermodesis for the treatment of chronic mallet finger in children

Authors	n	Age*	Time between injury-surgery*	Immobilization time* (weeks)	Outcomes (Crawford Criteria)	Follow-up (months)
De Boeck and Jaeken[7]	4	8.5 (7-12)	6.5 months (4-9)	4.75 (3-6)	4 Excellent	42 (8-72)
Kardestuncer et al.[4]	10	7.4 (1.4-17.8)	N/S	N/S (4-6)	8 Excellent 2 Good - Fair	78 (12-152)
This study	9	8.6 (1-15)	27.8 days (15-45)	5.6 (4-7)	8 Excellent 1 Fair	61 (12-106)

*Average (range). N/S = Not Specified

This study has limitations inherent to the methodological design that are worth mentioning. The sample was retrospectively analyzed and it is relatively small, although it is similar to the other two pediatric series treated with the same technique[4,7]. The time of progression of the injury was recorded according to the parents' anamnesis, which could be unreliable since some of them did not recall the exact moment of trauma. In spite of these limitations, we believe this study expands the information on the outcomes of surgery in late-presenting pediatric patients.

In our series, tenodermodesis allowed the anatomical reconstruction of the extensor mechanism in pediatric and adolescent patients with tendinous *mallet finger* and improved extension of the affected finger without limiting flexion. The clinical results of this study are encouraging in injuries with a delayed diagnosis.

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P. Eamara ORCID ID: http://orcid.org/0000-0001-7739-3568
L. Lanfranchi ORCID ID: http://orcid.org/0000-0002-5009-5293
V. M. Allende Nores ORCID ID: http://orcid.org/0000-0003-4893-7276
J. J. Masquijo ORCID ID: http://orcid.org/0000-0001-9018-0612

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